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(Design Build)

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

P.I. No.: 0010782
DISTRICT 7

Section 937 - Video Detection System

Delete Section 937 and substitute the following:

Section 937 – Video Detection System

937.1 General Description

This Work includes the procurement and installation of a vehicle detection system as shown in the plans. Ensure the vehicle detection system is capable of vehicle presence detection and traffic data collection meeting the general and specific requirements of this special provision. Ensure the firmware and software furnished and installed as part of an Intelligent Transportation System (ITS) project are the most current and approved releases or versions. Provide all equipment, materials, and work in accordance with all manufacturers' recommendations. All equipment, cables, and hardware must be part of an engineered system that is designed by the manufacturer to fully interoperate with all other system components.

Provide a vehicle detection system which produces vehicle presence, volume, speed, and occupancy data for each detected lane. Provide a vehicle detection system utilizing one of the following technologies as shown in the plans:

A. **Video Detection**

Install a video detection system which provides presence detection, vehicle counts, roadway occupancy, classification, and speed information to the Department's NaviGAtor Intelligent Transportation System. The video detection system includes, but is not limited to, camera image sensor(s), including the detector housing, mounting hardware, an application programming interface (API) and protocol for system communications, a video detection system processor, system management software, cabling between the detector and the cabinet, surge suppressors, terminations, and related equipment. The video detection system processors communicate through an Ethernet interface and TCP/IP (transmission control protocol/Internet protocol) connection to multiple Transportation Management Center (TMC) computers. The video detection system is typically used for gathering near real-time information about the flow of traffic on freeways, highways, or other designated roadway types.

B. **Microwave Detection**

Install a microwave radar detection system which provides presence detection, vehicle counts, classification, occupancy, and speed information to the Department's NaviGAtor Intelligent Transportation System (ITS). The microwave radar detection system includes, but is not limited to, microwave/ radar detectors, including detector housing, mounting hardware, an application programming interface (API) and protocol for system communications, system management software, cabling between the microwave detector(s) and the cabinet, surge suppressors, terminations, and related equipment. Microwave detection systems are typically used for gathering near real-time information about the flow of traffic on freeways, highways, or other designated roadway types.

C. **Intersection Video Detection (I-VDS)**

Install an Intersection Video Detection System (I-VDS) for use with traffic signal/ramp meter controllers in a traffic signal or ramp meter cabinet with card rack vehicle detector input files. The I-VDS system to be supplied uses one or more video cameras to collect and analyze video signals for detecting vehicle presence and passage, generating volume, occupancy, and speed data. The I-VDS includes, but is not limited to, video camera sensors, including the camera sensor housing and mounting hardware, intersection video detection system processor modules, system management software, output expansion modules which mount in the traffic signal controller cabinet input files, programming monitors, programming devices for system configuration through software, cabling between cameras sensors and the cabinet, surge suppressors, terminations, and related equipment.

937.1.02 Definitions

General Provisions 101 through 150.

937.1.03 Related References

A. **Standard Specifications**

Section 150 – Traffic Control

Section 639 – Strain Poles for Overhead Sign and Signal Assemblies

Section 647 – Traffic Signal Installation

Section 922 – Electrical Wire and Cable

Section 925 – Traffic Signal Equipment

Section 939 – Communication and Electronics Equipment

Section 940 – NaviGAtor Advanced Transportation Management System Integration

B. **Referenced Documents**

American National Standards Institute (ANSI)

American Society of Testing and Materials (ASTM)

EIA-170A

Electronic Industries Association (EIA) - 170A

FCC Part 15, Subpart J, Class A device requirements

Georgia DOT SOP 17 & 42

Highway Capacity Manual (current edition)

Manual on Uniform Traffic Control Devices (current edition)

National Electric Code (NEC) 210-19a., FPN No. 4

National Electrical Manufacturers Association (NEMA) TS1-1989 (R1994, R2000, R2005), Section 2.1.5.2, Section 2.1.12

NEMA TS-1-1989 (R1994, R2000, R2005)

NEMA TS2-2003 Type 2, Type 170 and Type 179 Standards

NEMA TS2-2003

NEMA 250 Type 4 enclosure standards

Underwriter's Laboratory Incorporated (UL) Submittals

937.1.04 Submittals

The following charts provide the Contractor with an outline of the submittal requirements for the equipment and components for the following pay items. This chart is to be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package. Provide submittal data for all equipment, materials, test procedures, and routine maintenance procedures required for these items as required in these Special Provisions.

Video Detection System Submittal Requirements

Material	Specification Reference	Catalog Cuts	Mfg. Spec.	Materials Cert.	Lab. Test Reports	Install. Proced.	Maint. Proced.	Warranty
Video Camera Sensor	937.2.01 A	X	X	X	X	X	X	X
Video Detection System Processor (All Types)	937.2.01A.2b	X	X	X	X	X	X	X
Cabinet Eqpt	937.3.01.A.3	X	X	X	X	X		X

Microwave Detection Submittal Requirements

Material	Specification Reference	Catalog Cuts	Mfg. Spec.	Materials Cert.	Lab Test	Install. Proced.	Test Plan	Maint. Proced.	Warranty	Submittal Due Date (Cal. Days after NTP)
Detector	937.2.02.A.1	X	X	X	X	X	X	X	X	60 Days
Housing	937.2.02.A.2	X	X	X	X		X	X	X	60 Days
Mounting Assembly	937.2.02.A.3	X	X	X			X		X	60 Days

Intersection Video Detection Submittal Requirements

Material	Specification Reference	Catalog Cuts	Mfg.	Shop.	Structural	Lab Test	Installation	Mainten.	Test	Test Plan	Test Reports	Training	Warranty	Submittal Due Date (Calendar Days after NTP)
Video Camera	937.2.03.A.1	X	X			X	X	X		X				60 Days
Video Camera Enclosure	937.2.03.A.1i	X	X			X	X	X		X				60 Days
Variable Focus Lens	937.2.03.A.1d	X	X			X	X	X		X				60 Days
Programming Monitor	937.2.03.A.2	X	X											60 Days
Programming Device	937.2.03.A.3	X	X											60 Days
Processor Module	937.2.03.A.4	X	X	X		X	X	X		X				60 Days
Output Expansion Module	937.2.03.A.5	X	X	X		X	X	X		X				60 Days
Processor Software	937.2.03.B.3	X	X				X	X		X				60 Days
Configuration Software	937.2.03.B.3b	X	X				X	X		X				60 Days
Terminal Blocks	937.3.02.A.3a	X	X							X				60 Days
Surge Suppression	937.3.02.A.3b	X	X	X			X	X		X				60 Days
Wiring Cabling & Harnesses	937.2.03.A.1j 937.3.01.A	X	X	X			X	X		X				60 Days
Training Plan	937.3.01											X	X	60 Days

For Video Detection Systems (VDS) and Microwave Detection, submit to the Engineer for approval, two (2) hard copies of the manufacturer's descriptive literature (catalog cuts), technical data, operational documentation, service and maintenance documentation and all other materials required within these specifications and also an electronic copy, which includes all the aforementioned documents, shall be placed on a CD as pdf documents and delivered to the Engineer.

For Intersection Video Detection (I-VDS), submit to the Engineer for approval, eight (8) hard copies of the manufacturer's descriptive literature (catalog cuts), technical data, operational documentation, service and maintenance documentation and all other materials required within these specifications and also an electronic copy, which includes all the aforementioned documents, shall be placed on a CD as pdf documents and delivered to the Engineer.

Products appearing on the Qualified Products List (QPL) are exempt from normal submittal requirements. These products have been evaluated by the Office of Traffic Operations and have proven their capability of meeting the appropriate Georgia Department of Transportation Specification. Any of these products may be used without submitting catalogue cuts, sampling or pre-testing. The Contractor shall submit a letter to the Field Engineer, stating which QPL items they will use. The Field Engineer and/or department designee must ascertain that the construction item is the same material identified on the appropriate QPL and will acknowledge receipt of these items in the project diary or as required by the Construction manual.

Provide as-built documentation of all detector installations after the completion of field tests.

937.2 Materials

937.2.01 Video Detection System

Use a video camera sensor that is compatible with the video detection system processor and meets the following technical and functional requirements:

A. **Technical Requirements**

1. Video Camera Sensor

   a. Lens: Lens must be housed in an environmentally sealed enclosure, watertight, protected from dust, and must comply with the most current NEMA 4 standards. Video sensor must have a motorized lens with variable focus and zoom control. Focal length must allow ±50 percent adjustment of the viewed detection scene.

   b. Input power: Ensure the vehicle detection system operates using a nominal input voltage at the field cabinet of 120 volts (AC). Ensure that the system's power supply will operate with an input voltage ranging from 89 to 135 volts (AC). For any device requiring a source input other than the standard 120 VAC, supply the appropriate means of conversion.

   c. Video camera sensor enclosure: Install the video camera sensor in a light colored enclosure to limit solar heating. Meet NEMA 250 type 4 enclosure standards. An adjustable sun shield that diverts water from the field of view shall also be included. Include a provision for waterproofing the connection of power, control, video signal cables, and wiring on the camera enclosure.

   d. Weight: 10 lbs maximum including mount, shield, and camera.

   e. Mounting: Ensure that the video camera sensor assembly, enclosure, and sun shield can be mounted using manufacturer's recommended hardware. The video camera sensor horizon shall be adjustable without removing the camera, mounting bracket and enclosure, or sun shield.

2. Video Detection System Processor

   a. Mounting

      Ensure the video detection system processor is rack mountable in a standard 19-inch rack assembly space conforming to Standard CEA-310, 2005, latest version/addendum, attaches to both sides of the rack, is not more than 10 inches (254 mm) deep, and is not more than 7 inches (178 mm) high. The video detection system processor shall be designed for mounting in an enclosed cabinet and/or Hub building without blower fans and mounting without insulation from other electronic devices such as power supplies, communications equipment, etc. The video detection system shall meet NEMA TS-2 temperature requirements.

   b. Electrical and Power Requirements

      Power the video detection system processor by 120 VAC, 60 Hz, single phase, and draw a maximum of 1.0 A. Size power conductors from the power source for the video detection system processor input so that no more than a 3% voltage drop is experienced (NEC 210-19 a., FPN No. 4). The video detection system processor shall have transient protection that meets the requirements of NEMA TS1-1989 (R1994, R2000, R2005) and NEMA TS2-2003 standards.

      Power to the video detection system processor shall be from the cabinet equipment outlet.

      1) Video Detection System Processor, Type A

         a) Provide at least two (2) video inputs on the video detection system processor such that signals from up to two (2) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time. Use BNC connectors on the back of the video detection system processor for all video inputs. Use a BNC

connector on the front or back of the video detection system processor for video output.

2) Video Detection System Processor, Type B

a) Provide at least four (4) video inputs on the video detection system processor such that signals from up to four (4) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time. Use BNC connectors on the back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

c. Environmental Requirements

1) Video Detection System Processor, Type A

Provide a video detection system processor that operates reliably in a typical roadside traffic cabinet environment. Provide internal cabinet equipment and a video detection system processor that meet the environmental requirements of NEMA TS1-1989 (R1994, R2000, R2005).

2) Video Detection System Processor, Type A

a) Operating ambient temperature range: -30°F to 140°F (-34°C to 60°C). Additionally, include a heater to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interfere with the operation of the video camera sensor electronics, or cause interference with the video signal.

b) Humidity range**:** 5-95% humidity per NEMA TS1-1989 (R1994, R2000, R2005), Section 2.1.5.2.

c) Vibration: Do not allow vibration to impair performance when the camera is mounted on 96 ft (29 m) or shorter pole. Provide a video camera sensor and enclosure that maintains its functional capability and physical integrity when subjected to a vibration of 5 to 30 Hz up to 0.5 gravity applied to each of three mutually perpendicular axes (NEMA TS1-1989(R1994, R2000, R2005), Section 2.1.12).

d) Shock: Ensure the video camera sensor & enclosure can withstand a 10G±1G shock. Neither permanent physical deformation nor inoperability of the video camera sensor and enclosure can be sustained as a result from this shock level.

e) Acoustic Noise: Provide a video camera sensor and enclosure that can withstand 150 dB for 30 minutes continuously, with no reduction in function or accuracy.

B. **Functional Requirements for Vehicle Detection Systems**

In order to be approved for use in GDOT projects, a detection product must be able to provide certain data elements at or better than a minimal defined accuracy level. This section defines the minimally required functional aspects of the system as well as the required accuracy levels. It also outlines the testing process that will be used to determine whether a proposed video detection system product meets these specifications.

1. Ensure that Video Detection Systems proposed for use in the Navigator system provides vehicle presence, speeds, vehicle counts and roadway occupancies on a lane-by-lane basis. Verify that the system can emulate the output of a pair of 6 ft. by 6 ft. in-pavement loops spaced 16 ft apart. Ensure that the Video Detection System is capable of providing the above data for seven (7) lanes plus two shoulders with one video camera sensor. Verify that the system responds with the accumulated traffic data as collected since the last request.

2. Verify that the detection system is IP-addressable and that all communication addresses are user programmable. Ensure the setup program assigns an IP address to the detection processor. Ensure that communications to the system are either in serial format using an Electronic Industries Alliance (EIA) standard EIE-232 communication or an Internet Protocol (IP) interface as approved by GDOT's

Information Technology group. Ensure the system supports Point-to-Point Protocol (PPP), Point to Multi-Point Protocol (PMPP) and Ethernet Protocols.

3. Verify that the traffic data collected by the Video Detection System is stored within internal non-volatile memory within the video detection system processor. Perform software updates through an Ethernet, serial, or USB port. Verify that data can be retrieved from the system either locally or via requests from computers at the central Transportation Management Center (TMC) over the communications network. Verify that the system configuration data and system software is also stored within internal non-volatile memory within the video detection system processor. Perform software updates through an Ethernet, serial, or USB port

4. Ensure the video detection system processor front panel includes a visual display of the status of each video input. Indicators shall display, at a minimum, the status of video detection system processor communications, the status of the video detection system processor, the status of communications, and whether or not each video camera sensor is actively detecting. Include an Embedded HTTP Server in the video detection system processor. The Embedded HTTP Server shall allow a remote user with a standard web browser to gain remote access, collect data, control, and configure the VDS.

5. Ensure the Video Detection System includes computer software, which enables the user to program, calibrate, operate and view current status of all system features using a laptop computer, or network-connected workstation at the central TMC. Ensure the system allows the user to view live video from the image sensor with the programmed detectors overlaying the image. Ensure individual vehicle actuations can be viewed while observing the live video.

6. Ensure the Video Detection System configuration data can be uploaded and saved to a laptop or TMC workstation computer for later re-loading to the video detection processor if necessary.

7. Ensure that the system offers an open Application Programming Interface (API) and software development kit (SDK) for GDOT developers and their consultants to integrate the Video Detection System with Navigator Central Software or other third-party software and systems. Furnish needed software licenses for the system.

8. Furnish software that is compatible with the Department's Navigator traffic management system software and that any software associated with the Video Detection System does not adversely affect the operation of the overall Navigator system.

9. Ensure the system user can use a laptop to reprogram, calibrate, adjust or alter any previously defined detector configurations in the field and also reprogram any detector configurations over the network or from a TMC workstation. Ensure no periodic adjustments or fine-tuning is required except in the case of physical roadway changes such as lane-shifts, new construction or closures. Initial configuration of the detection system shall be done with a programming device that is either a keyboard/keypad or stationary track ball pointing devices. Connect the programming device to the front of the processor module through a USB, DB9, or PS/2 connector. Provide a programming device that is PC compatible.

10. Provide software that can communicate concurrently between multiple users and multiple video detection processors on the same network without any interruption or conflict with the normal polling cycle.

C. **Accuracy Requirements for Video Detection Systems**

Provide a Video Detection System that meets the below minimum accuracy requirements for both daytime and night time conditions:

1. For volume (vehicle counts): 95% (no more than 5% missed actuations).

2. For speed measurement: 95% (no more than 5% error in speed calculation)

3. For occupancy measurement: 95% (no more than +/- 5% missed actuations)

4. For presence detection: 95% (no more than +/- 5% error in missed actuations)

D. **Testing**

Vendors are required to submit an independent test evaluation reports from a third party which verifies the accuracies stated within their specifications.

Independent third-party verification (ITPV) is defined as the evaluation of the conceptual, functional, and technical requirements of a product being reviewed by one or more independent third parties qualified by their education, training, and experience in the same discipline, to judge the worthiness of the products' likelihood of achieving the intended objectives and anticipated outcomes.

Develop and submit plans for pre-installation and post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.01B and the accuracy requirements stipulated in Section 937.2.01C. Provide the Engineer with Application Protocol Interface (API) documentation and Software Development Kit (SDK) for the video detection system.

GDOT project engineer will provide this documentation to GDOT Information Technology (I.T.) staff or GDOT's designated software consultant for review and determination that the proposed Video Detection System includes an API that is acceptable for integration with the Navigator Intelligent Transportation System. GDOT will have 30 days from receipt of the API and SDK to make this determination. GDOT is not required to write the full Detection System interface to Navigator at this point in the testing process.

1. Pre-installation test requirements: Include at a minimum the following procedures in the test plan to demonstrate the Video Detection System provides all the functional requirements in Section 937.2.01B and meets the accuracy requirement stipulated in Section 937.2.01C. Installation of detection systems will not begin until the pre-installation test requirements have been successfully completed.

   a. Install a test video detection system at a location determined by GDOT. Install a new video sensor for the test. Install a test video detection system that includes all components of the system including a video sensor, a video detection processor and software.
   b. Connect the Video Detection System processor to the GDOT communications network via a GDOT-provided field switch. Assign an IP address to the processor per GDOT's direction.
   c. From the nearest Hub building, configure the Video Detection System processor to gather the data according to the requirements as specified in Section 937.2.01B.9. Verify that the configuration data is stored in non-volatile memory.
   d. Demonstrate that each required data element is gathered by the system at the user-specified interval. Use 20-seconds as the interval for demonstration testing. Prove the accuracy of the detection system meets requirements in Section 937.2.01C by:

      1) Driving a vehicle of known speed and length through the detection zone and observing and recording the speed and length calculated by the system. Repeat this measurement at least ten times.

      2) Record fifteen minutes of traffic video from the image sensor at the same time the detection system is collecting data. Manually count the recorded traffic video and verify the count data calculated by the detection system meets the required accuracy requirements.

      3) Perform the above accuracy tests in both night and day conditions.

      4) Upon GDOT acceptance of pre installation test results, begin the installation of VDS as specified in the plans.

      5) If any part of the pre installation test fails, the contractor has up to two subsequent attempts to correct the problem to the satisfaction of the Engineer. All these subsequent tests must be completed within a two week period from the date of initial failure.

2. Post-installation test procedures: Utilize the following test procedures after the video detection system has been installed in its entirety as shown on the Plans. Commence no post-installation testing until all video detection systems in the project have been configured/calibrated to gather speed, volume and occupancy and

programmed to communicate on the GDOT network. At this stage of testing, GDOT will be required to have in place the necessary interfaces to the Video Detection System.

a. Inspect all vehicle detection system field components to ensure proper installation and cable termination.
b. Verify that field construction has been completed as specified in the plans.
c. Inspect the quality and tightness of ground and surge protector connections.
d. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.
e. Verify that the installation of cables and connections between all detectors and field cabinets are as specified in the Plans
f. Demonstrate that each Video Detection System is fully operational and gathering the required data types at the specified interval. Perform this test from the hub building through which the detection system is connected.
g. Upon satisfactory completion of step f, GDOT will add the new video detection system(s) into the central NaviGAtor system
h. Begin a 30-day burn test and ensure the system remains fully operational during the 30 day period as stipulated in Section 647.3.06.C.

937.2.02 Microwave Detection System

A. **Technical Requirements**

Provide a microwave detection system that meets the following minimum requirements:

1. Microwave Detector

- A frequency band of 10.525 GHz or approved spectral band must be used.
- The transmitter power cannot exceed 10 milli-watts
- Ensure compliance with the limits for a Class A digital device pursuant to Part 15 of the FCC rules
- A noise level less than 55 dBA when measured one meter away from the device is required
- Ensure the microwave detector operates on 12-24 VDC power provided. A power supply shall be included.

Ensure the detector uses one interface connector that provides power to the unit, contact closure wire pairs for each detection zone, and Ethernet communication lines for operations, programming, testing, or modem interface

- A coverage range between 10 and 200 feet is required.
- A diagnostic self-test of all detector functions shall be included.
- Data communications via Ethernet communications supporting TCP/IP Protocol must be provided.

Provide a microwave radar detector that operates under the following environmental conditions:

- Ambient temperature range of –29°F to 165°F (-37°C to 74°C)
- Relative humidity from 5 to 95 percent, non-condensing
- A power surge of ± 1kV surge (rise time = 1.2 µsec, hold = 50 µsec) should be applied in differential mode to all lines, power and output, as defined by IEC/EN 61000-4-5 standards
- Ensure the microwave detector is resistant to vibration in accordance with NEMA TS-1 (Section 2.1.12) or approved equivalent
- Ensure the microwave detector is resistant to shock in accordance with NEMA TS-1 (Section 2.1.13) or approved equivalent

2. Housing

Provide a microwave radar detector housing that meets the following requirements:

- Ensure compliance with the requirements of a NEMA type 3R enclosure
- The outside dimensions, including fittings, do not exceed 1,000 cubic inches (LxWxH).
- The total weight (including detector) does not exceed 8 pounds.

3. Mounting Assembly

Provide a microwave radar detector mounting assembly that meets the following requirements:

- The mounting assembly shall be all painted steel, stainless steel, or aluminum construction
- A minimum load of 20 pounds shall be supported.

4. Power Supply

Provide a power supply recommended by the microwave radar detector manufacturer that meets the following minimum requirements:

- A nominal output of 24VDC regulated with the ability to operate a minimum of 2 radar detectors simultaneously over an ambient temperature range of –29°F to 165°F (-34°C to 74°C) must be provided.
- A nominal input voltage of 120 VAC must be provided by the equipment cabinet power source
- The power supply shall be mounted to cabinet side panel, or as approved by the Engineer.

B. **Functional Requirements for Microwave Detection Systems**

In order to be approved for use in GDOT projects, a microwave detection system must be able to provide certain data elements at or better than a minimal defined accuracy level. This section defines the minimally required functional aspects of the microwave detection system as well as the required accuracy levels. It also outlines the testing process that will be used to determine whether a proposed microwave detection system product meets these specifications.

1. Ensure that Microwave Detection Systems proposed for use in the Navigator system provides vehicle presence, classification, speeds, vehicle counts and roadway occupancies on a lane-by-lane basis at a user definable reporting period between 20 to 600 seconds.

2. Verify that the system can emulate the output of a pair of 6 ft. by 6 ft. in-pavement loops spaced 16 ft apart. Ensure that the Microwave Detection System is capable of providing the above data for seven (7) lanes plus two shoulders with one microwave detector. Verify that the system responds with the accumulated traffic data as collected since the last request.

3. Verify that the detection system is IP-addressable and that all communication addresses are user programmable. Ensure the setup program assigns an IP address to the detection processor. Ensure that communications to the system are either in serial format using an Electronic Industries Alliance (EIA) standard EIE-232 communication or an Internet Protocol (IP) interface. Data communications are to be through Ethernet communications supporting TCP/IP Protocol. Ensure the system supports Point-to-Point Protocol (PPP), Point to Multi-Point Protocol (PMPP) and Ethernet Protocols. A diagnostic self-test of all detector functions should be included.

4. Verify that the traffic data collected by the Microwave Detection System is stored within internal non-volatile memory. Verify that data can be retrieved from the system either locally or via requests from computers at the central Transportation Management Center (TMC) over the communications network. Verify that the system configuration data and system software is also stored within internal non-volatile memory.

5. Ensure the Microwave Detection System includes computer software for the user to program, calibrate, operate and view current status of all system features using a laptop computer or network-connected workstation at the central TMC. Initial configuration of the detection system shall be done with a programming device that is either a keyboard/keypad or stationary track ball pointing devices. Connect the programming device to the front of the processor module through a USB, DB9 or PS/2 connector. Provide a

programming device that is PC compatible. Ensure the system allows the user to view live actuations from the microwave detector with the programmed detectors overlaying a representation of the roadway.

6. Ensure the Microwave Detection System configuration data can be uploaded and saved to a laptop or TMC workstation computer for later re-loading to the video detection processor if necessary.

7. Ensure that the system offers an open Application Programming Interface (API) and software development kit (SDK) for GDOT developers and their consultants to integrate the Microwave Detection System with Navigator Central Software or other third-party software and systems. Furnish needed software licenses for the system.

8. Furnish software that is compatible with the Department's Navigator traffic management system software and that any software associated with the Microwave Detection System does not adversely affect the operation of the overall Navigator system.

9. Ensure the system user can use a laptop or TMC workstation to reprogram, calibrate, adjust or alter any previously defined detector configurations. Ensure no periodic adjustments or fine-tuning is required except in the case of physical roadway changes such as lane-shifts, new construction or closures. Initial configuration of the detection system shall be done with a programming device that is either a keyboard/keypad or stationary track ball pointing devices. Connect the programming device to the front of the processor module through a USB, DB9 or PS/2 connector. Provide a programming device that is PC compatible. Provide software that can communicate concurrently between multiple users and multiple video detection processors on the same network without any interruption or conflict with the normal polling cycle.

C. **Accuracy Requirements for Microwave Detection Systems**

Provide a Microwave Detection System that meets the below minimum accuracy requirements for both daytime and night time conditions:

1. For volume (vehicle counts): 95% (no more than +/- 5% missed actuations).
2. For speed measurement: 95% (no more than +/- 5% error in speed calculation)
3. For occupancy measurement: 95% (no more than +/- 5% missed actuations)
4. For vehicle classification: 95%(no more than +/- 5% error in classification calculation)
5. For presence detection: 95% (no more than +/- 5% missed actuations)

D. **Testing**

Vendors are required to submit an independent test evaluation report from a third party which verifies the accuracies stated within their specifications.

Independent third-party verification (ITPV) is defined as the evaluation of the conceptual, functional, and technical requirements of a product being reviewed by one or more independent third parties qualified by their education, training, and experience in the same discipline, to judge the worthiness of the products' likelihood of achieving the intended objectives and anticipated outcomes.

Develop and submit plans for pre-installation and post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.02B and the accuracy requirements stipulated in Section 937.2.02C. Provide the Engineer with Application Protocol Interface (API) documentation and Software Development Kit (SDK) for the video detection system.

1. Pre-installation test requirements: Include at a minimum the following procedures in the test plan to demonstrate the Microwave Detection System provides all the functional requirements in Section 937.2.02B and meets the accuracy requirement stipulated in Section 937.2.02C. Installation of detection systems will not begin until the pre-installation test requirements have been successfully completed.

a. Install a test microwave detection system at a location determined by GDOT. Install a new microwave detector for the test. Install a test video detection system that includes all components of the system including a microwave detector, microwave detector processor and software.

b. Connect the Microwave Detection System processor to the GDOT communications network via a GDOT-provided field switch. Assign an IP address to the processor per GDOT's direction.

c. From the nearest hub building, configure the Microwave Detection System processor to gather the data required in Section 937.2.02B.9. Verify that the configuration data is stored in non-volatile memory. Initial configuration of the detection system shall be done with a programming device that is either a keyboard/keypad or stationary track ball pointing devices. Connect the programming device to the front of the processor module through a USB, DB9 or PS/2 connector. Provide a programming device that is PC compatible.

d. Demonstrate each required data element is gathered by the system at the user-specified interval. Use 20-seconds as the interval for this phase of testing.

Prove the accuracy of the detection system meets requirements in Section 937.2.02C by:

1) Driving a vehicle of known speed through the detection zone and observing and recording the speed calculated by the system. Repeat this measurement at least five times.

2) Perform the above accuracy tests in both rainy and dry conditions.

3) Upon GDOT acceptance of pre installation test results, begin the installation of microwave detection system as specified in the plans.

4) If any part of the pre installation test fails, the contractor has up to two subsequent attempts to correct the problem to the satisfaction of the Engineer. All these subsequent tests must be completed within a two week period from the date of initial failure.

2. Post-installation test procedures: Utilize the following test procedures after the microwave detection system has been installed in its entirety as shown on the Plans. Commence no post-installation testing until all microwave detection systems in the project have been configured/calibrated to gather speed, volume, classification, and occupancy and programmed to communicate on the GDOT network. At this stage of testing, GDOT will be required to have in place the necessary interfaces to the Microwave Detection System.

a. Inspect all microwave detection system field components to ensure proper installation and cable termination.

b. Verify that field construction has been completed as specified in the plans.

c. Inspect the quality and tightness of ground and surge protector connections.

d. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.

e. Verify that the installation of cables and connections between all detectors and field cabinets are as specified in the Plans

f. Demonstrate that each Microwave Detection System is fully operational and gathering the required data types at the specified interval. Perform this test from the hub building through which the detection system is connected.

g. Upon satisfactory completion of step f, GDOT will add the new microwave detection system(s) into the central NaviGAtor system

h. Begin a 30-day burn test and ensure the system remains fully operational during the 30 day period as stipulated in Section 647.3.06.C.

937.2.03 Intersection Video Detection (I-VDS)

A. **Technical Requirements**

1. Video Camera Sensor

Send a video signal from the video camera sensor to the processor, using high resolution, video camera sensors as the primary video source for real-time vehicle detection. Use optical filters and/or electronic circuitry in the video camera sensor to compensate for blooming at night caused by headlights and minor vibration caused by wind. Include a heater at the front of the enclosure to prevent the formation of ice and condensation in cold weather. Ensure that the heater does not interfere with the operation of the video camera sensor electronics, or cause interference with the video signal, where applicable. As a minimum, meet the following requirements for each video camera sensor assembly installation:

a. Use a 1/4" to 1" interline or frame transfer charge coupled device (CCD). Do not use complimentary metal-oxide semiconductor (CMOS) image sensors.

b. Use Active pixel elements that are 768 Horizontal, 494 Vertical (minimum)

c. The video standard should be compliant with NTSC Standard, RS-170A Compliant (available as EIA-170A specification)

d. Use an 8-48 mm variable focal length lens that is adjustable from outside the camera enclosure, where applicable. Provide an Electric Lens Adjustment Device and associated wiring to adjust the variable focal length lens

e. A resolution of 380 Horizontal TVL, 350 Vertical TVL minimum is required.

f. Ensure the Automatic gain control (AGC) is a 20 dB minimum. Do not allow AGC to be applied until the automatic iris control has fully opened the aperture

g. For Electromagnetic interference, ensure compliance with FCC Part 15, Subpart J, Class A device requirements, which apply to the video camera sensor and associated connected equipment in their installed condition

h. Power the video camera sensors with 115 VAC+/-10%, 60 Hz nominal +/-3 Hz. Size the power conductors from the power source to the camera input so that no more than a 3% voltage drop is experienced (NEC 210-19 a., FPN No. 4). Include a provision at the rear of the camera enclosure for a waterproof connection of power and video signal cables. Provide power from the cabinet power source through a surge suppressor and then to the video camera sensor.

i. The Video camera sensor enclosure shall be installed in a light colored enclosure to limit solar heating. Meet NEMA 250 Type 4 enclosure standards for the enclosure and seal the enclosure to prevent sand, dirt, dust, salt and water from entering. Affix a sun shield visor to the front of the enclosure which is sufficiently adjustable to divert water away from the video camera sensor lens and also prevent direct sunlight from entering the iris when mounted in its installed location.

j. Provide outdoor-rated power, coaxial video, and lens adjustment (where applicable) wiring from the sensor enclosure to the cabinet in accordance with the manufacturer's recommendations. However, if the sensor junction box is used, seal the wiring connection at the housing from water or dust entry into the housing. For the standard video camera sensor mounting as shown in the details, provide approximately 4 ft (1.22 m) long wiring to enter the bottom of the junction box and terminate inside. Provide a male BNC connector with gold-plated body and center pin at the junction box end of the coaxial video cable. When providing a lens adjustment harness, ensure that the connector on the harness properly mates to the lens adjustment control unit.

k. The maximum weight of the video camera sensor shall be 10 lbs (4.5 kg) (maximum with mount, shield, and camera).

l. Ensure the size of the video camera sensor is (HxWxL): 5" x 5" x 18" [130 mm x 130 mm x 460 mm] (maximum, including camera enclosure)

2. Programming Monitor, Type A

As a minimum, provide a 9" high resolution video monitor with a minimum of 750 TVL, (1) input, (1) output BNC connection, IVp-p, input impedance high (loop through) 75 ohms terminated. Provide 6-ft factory manufactured high flex coaxial video cables with BNC connectors with each programming monitor. If more than one video input is received provide the ability to monitor all inputs on the monitor by using a video selector switching device.

3. Programming Device

Configure the detection system with a Programming Device that is either a keyboard/keypad or stationary track ball pointing device. Connect the Programming Device to the front of the processor module through a USB, DB9, PS/2 connector. Provide a Programming Device that is PC compatible.

4. Processor Module

Provide a processor module, which performs video image processing, that completely fits within the loop detector slots of the traffic signal/ramp meter controller cabinet input file and that provides a standard relay closure detector input to the controller. Provide four detector outputs through the processor module which communicate through the edge card connector. Use a module that is not wider than two standard input file slots. Include detection indicators on the front panel of the processor module for each of the four channels of detection provided through that module to indicate detector output in real time when the system is operational. Include a BNC connector with gold plated center pin or an RCA jack on-the front panel for video output to the Programming Monitor, and include a USB, DB9 or PS/2 connector on the front panel to connect the Programming Device. Send the video signal over coaxial cable from the video camera sensor to the Processor Module using one of the two following methods:

a. Connect the coaxial cable from the video camera sensor to the surge suppressor and from the surge suppressor connect the coaxial jumper cable with a 90 degree elbow gold-plated BNC connector to BNC connector on the front panel of the Processor Module; or

b. Connect the coaxial cable from the video camera sensor to the surge suppressor and connect the coaxial jumper cable from the surge suppressor to the loop detector panel using a spade lug connection such that the video signal communicates from the loop detector panel to the Processor Module through the cabinet input file.

Provide power to the processor modules through the input file. The processor modules are defined as follows:

- Processor Module, Type A - provide one (1) video camera sensor input
- Processor Module, Type B – provide two (2) video camera sensor inputs
- Processor Module, Type C – provide four (4) video camera sensor inputs

5. Output Expansion Modules, Types A and B

Provide detector outputs, in addition to detector outputs provided through the processor module, through an output expansion module that mounts in the traffic signal/ramp meter controller cabinet input file and that provides a standard relay closure detector input to the controller. Provide 2 outputs through the edge card connector of each module. Connect the expansion module to the processor module with a cable that has standard modular connectors. Use a module that is not wider than 1 detector card per two additional detector outputs or that is not wider than 2 detector cards per four additional detector outputs. Include detection indicators on the front panel of the output expansion module for each channel of detection provided through that module to indicate detector output in real time when the system is operational.

The Type B output expansion module provides 4 outputs through the edge card connector of each module. The procedure for connecting the expansion module to the processor module is the same as shown above.

Provide power to the expansion module through the input file.

6. Environmental

a. Video Detection System Processor

Provide a video detection system processor that operates reliably in a typical roadside traffic cabinet environment. Provide internal cabinet equipment and a video detection system processor that meet the environmental requirements of NEMA TS1-1989 (R1994, R2000, R2005).

b. Video Camera Sensor

1) Provide video camera sensors that operate reliably in a roadside environment. Provide video camera sensors that meet the environmental requirements of NEMA TS1-1989 (R1994, R2000, R2005), Section 2.1.5.2. Provide video camera sensors that operate from -31 °F to 120 °F (-35 °C to +50 °C) from 5% to 95% relative humidity. An operating ambient temperature range from -30°F to 140°F (-34°C to 60°C) is required. Additionally, include a heater to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interfere with the operation of the video camera sensor electronics, or cause interference with the video signal.

2) Vibration: Ensure that vibration does not impair performance when the camera is mounted on 50' (15 m) or shorter pole. Do not allow vibration to impair performance when the camera is mounted on 96 ft (29 m) or shorter pole. Provide a video camera sensor and enclosure that maintains its functional capability and physical integrity when subjected to a vibration of 5 to 30 Hz up to 0.5 gravity applied to each of three mutually perpendicular axes (NEMA TS1-1989(R1994, R2000, R2005), Section 2.1.12).

3) Processor and Expansion Modules: Provide processor and expansion modules that operate reliably in a typical roadside traffic cabinet environment. Provide equipment that meets the environmental requirements of NEMA TS1-1989 (R1994, R2000, R2005) and NEMA TS2-2003 standards and the environmental requirements for Type 170 controllers. Provide equipment that operates from -29 °F to 140 °F (–34 °C to +60 °C) from 0% to 95% relative humidity, non-condensing.

4) Shock: Ensure the video camera sensor & enclosure can withstand a 10G±1G shock. Neither permanent physical deformation nor inoperability of the video camera sensor and enclosure can be sustained as a result from this shock level.

5) Acoustic Noise: Provide a video camera sensor and enclosure that can withstand 150 dB for 30 minutes continuously, with no reduction in function or accuracy.

7. Electrical and Power Requirements

a. Video Detection System Processor

Power the video detection system processor by 120 VAC, 60 Hz, single phase, and draw a maximum of 1.0 A. Size power conductors from the power source for the video detection system processor input so that no more than a 3% voltage drop is experienced (NEC 210-19 a., FPN No. 4). The video detection system processor shall have transient protection that meets the requirements of NEMA TS1-1989 (R1994, R2000, R2005) and NEMA TS2-2003 standards. Power to the video detection system processor shall be from the card rack.

b. Video Camera Sensor

Use a video camera sensor that is compatible with the video detection system processor and meets the following input power requirements: 115 VAC, 60 Hz. The I-VDS PDA shall obtain power from the 15 amp equipment breaker in the traffic signal/ramp metering cabinet PDA panel. Size power conductors from the power source to the camera input so that no more than a 3% voltage drop is experienced (NEC 210-19 a., FPN No. 4). Include a provision at the rear of the camera enclosure for the waterproofing of the connection of power and video signal cables.

8. Documentation

Provide the following documentation in the documentation pouch of each traffic signal/ramp meter cabinet:

- One operation manual with programming instructions

- One maintenance manual with schematics
- Three legible wiring prints showing all I-VDS components and connections with the cabinet

B. **Functional Requirements for I-VDS**

1. General Requirements

In order to be approved for use in GDOT projects, Intersection Video Detection Systems (I-VDS) must be able to provide certain data elements at or better than a minimal defined accuracy level. This section defines the minimally required functional aspects of the system as well as the required accuracy levels. It also outlines the testing process that will be used to determine whether a proposed video detection system product meets these specifications.

a. Ensure that I-VDS detect vehicle presence and passage, speeds, vehicle counts, classification, and roadway occupancies on a lane-by-lane basis. Verify that the system can emulate the output of a pair of 6 ft. by 6 ft. in-pavement loops spaced 16 ft apart. Ensure the I-VDS are capable of providing the above data for 24 detection zones with one video camera sensor. Verify that the system responds with the accumulated traffic data as collected since the last request.

b. Verify that the traffic data collected by the I-VDS is stored within internal non-volatile memory. Verify that data can be retrieved from the system locally. The port connector shall be on the front of the detection system processor for easy access. Ensure that the detection system processor software is stored in non-volatile memory within the video detection system processor. Perform software updates through a serial, Ethernet, or USB port.

c. Ensure the system user can use a laptop to reprogram, calibrate, adjust or alter any previously defined detector configurations. Ensure no periodic adjustments or fine-tuning is required except in the case of physical roadway changes such as lane-shifts, new construction or closures. Initial configuration of the detection system shall be done with a programming device that is either a keyboard/keypad or stationary track ball pointing devices. Connect the programming device to the front of the processor module through a USB, DB9 or PS/2 connector. Provide a programming device that is PC compatible.

d. The detection system processor front panel shall include a visual display of the status of each video input and the status of the video detection system processor in general. Indicators shall display, at a minimum, the status of the processor the status of communications, and whether or not each video camera sensor is actively detecting.

2. System Hardware: Provide a detection system that does not require any equipment external to the traffic signal/ramp meter controller cabinet input file (excluding the video camera sensor, video camera sensor power connection, circuit breakers and surge suppression for video or data). Mount the processor and expansion modules in the traffic signal/ramp meter controller cabinet input files, using the edge card connector to obtain power and provide contact closure outputs. Rewiring of the backplane or any other cabinet panel for the system is not permitted except for power and grounding for the interface panel, wiring from the video camera sensor to the loop detector panel for the video signal and wiring to obtain power for the video camera sensor.

Provide a system capable of providing a minimum of eight detector outputs per video camera sensor. Provide all detector outputs through edge card connectors of the processor module and output expansion module(s). Rewiring external to the edge connectors is not permitted for obtaining a minimum of eight outputs for one video camera sensor.

3. System Software System Processing Software: On the processor module that mounts in the traffic signal/ramp meter controller cabinet input file, include the software that processes the video camera sensor signals and converts the signals into detector outputs. Detect either approaching or receding vehicles in multiple lanes within the field of view (FOV) of each video camera sensor. Provide the capability of detecting vehicles in up to 24 detection zones per video camera sensor with the detection system. Allow the detection zones to be combined to form an output using the AND, OR and NOT logical functions.

a. Detection Compensation: Provide the capability for the processor to compensate for camera movement attributable to temperature effects, wind shifting, pole sway, pole expansion, or vibration.

b. System Configuration Software: On the processor module, include the configuration software to program the detection system, including the detection zones. Perform programming by accessing the software through a Programming Monitor and a Programming Device.

4. Programming Requirements

Employ menus for the Configuration Software. Provide the capability through the Configuration Software for the user to define detection zones through interactive graphics by placing lines and/or boxes in an image on a Programming Monitor. Provide the capability for the user to redefine previously defined detection zones.

5. Detection Zone Placement and Manipulation:

Allow up to 24 detector zones to be defined through the software for each video camera sensor. Provide the capability to place vehicle detection zones anywhere within the field of view of the video camera sensors through the Configuration Software. Use detection zones that are lines or boxes drawn in each visible lane or area of desired detection. Provide the capability to use one detection zone to replace multiple inductive loop detectors. Detection zones may overlap if necessary. Provide the ability for the user to assign logical functions such as AND, OR and NOT to one detector or a group of detectors.

On the Programming Monitor, display the detection zones superimposed on the video camera sensor's images. Provide the capability to create detection zones of varying size and shape to allow best coverage of the viewable roadway lanes and ramps. Provide the capability to save the detection zone format on the processor module card once drawn for a particular video camera sensor image. Provide the capability for the user to view the currently active detector zone format of the processor module via a Programming Monitor.

a. Detection Zone Editing: Provide the capability to edit existing detector configurations using a Programming Monitor with the Programming Device used to perform the programming functions.

b. Confirmation: When viewing vehicle actuations in real time on the Programming Monitor, indicate the passage or presence of each vehicle detected by each detection zone by changing the color or intensity of that particular zone.

c. Detection During Reconfiguration: Provide the capability for the detection system to continue detecting vehicles on all existing zones during reconfiguration, except on the zone that is being reconfigured.

d. I-VDSn: I-VDSn refers to all of the specific I-VDS components necessary for operation and detection on one approach leg of an intersection. The "n" denotes the approach's through-movement controller phase in the nomenclature of a typical 8-phase dual-ring intersection operation (e.g., I-VDS2, I-VDS4, I-VDS6, I-VDS8) when four video camera sensors are installed. If more than four video camera sensors are installed, the "n" denotes the controller phase being detected in the nomenclature of a typical 8-phase dual ring intersection operation. I-VDSn is also used as a prefix to identify the individual I-VDS components of the "n" approach as follows:

- I-VDSnVCS: the video camera sensor for approach "n"
- I-VDSnCC: the coaxial cable from the video camera to the controller cabinet for approach "n"
- I-VDSnPC: the video camera sensor power cable from the video camera to the controller cabinet for approach "n"
- I-VDSnCSS: the coaxial cable surge suppressor in the controller cabinet for approach "n"
- I-VDSnCJ: the coaxial jumper cable from the coaxial surge suppressor in the controller cabinet to the processor module or detector panel for approach "n"
- I-VDSnPM: the processor module for approach "n", where a Processor Module, Type A is installed
- I-VDSpn/snPM: the processor module for approach "pn" and "sn", where "pn" is the primary approach and "sn" is the secondary approach, where a Processor Module, Type B is installed.
- Occupancy: individual lane occupancy measured in percent of time

e. Ramp Meter Controller Cabinet Input File: A Ramp Meter Controller Cabinet Input File is a chassis within a traffic signal cabinet rack that has slots where a detector card provides detector output to the traffic signal controller through its edge card connectors. The backplane connector pin output of the edge connectors conforms to Georgia traffic signal controller cabinet standards for the cabinet type specified in the plans.

f. I-VDSnnn: I-VDSnnn refers to all of the specific I-VDS components necessary for operation and detection related to ramp metering installations based on direction, type of detection and lane assignments The first "n" denotes the approach direction (north, south, east or west) and the second "n" denotes the type of detection, P=Passage Detection Zones, D=Demand Detection Zones, Q=Queuing Detection Zones, ML=Mainline Detection Zones, the third "n" denotes the lane assignment (lane 1=L01, lane 2=L02,lane =L03, lane= L04), the (e.g., I-VDSnPL01, I-VDSsDL02, I-VDSeQL03, I-VDSwMLAL04). The typical ramp metering layout is shown below:

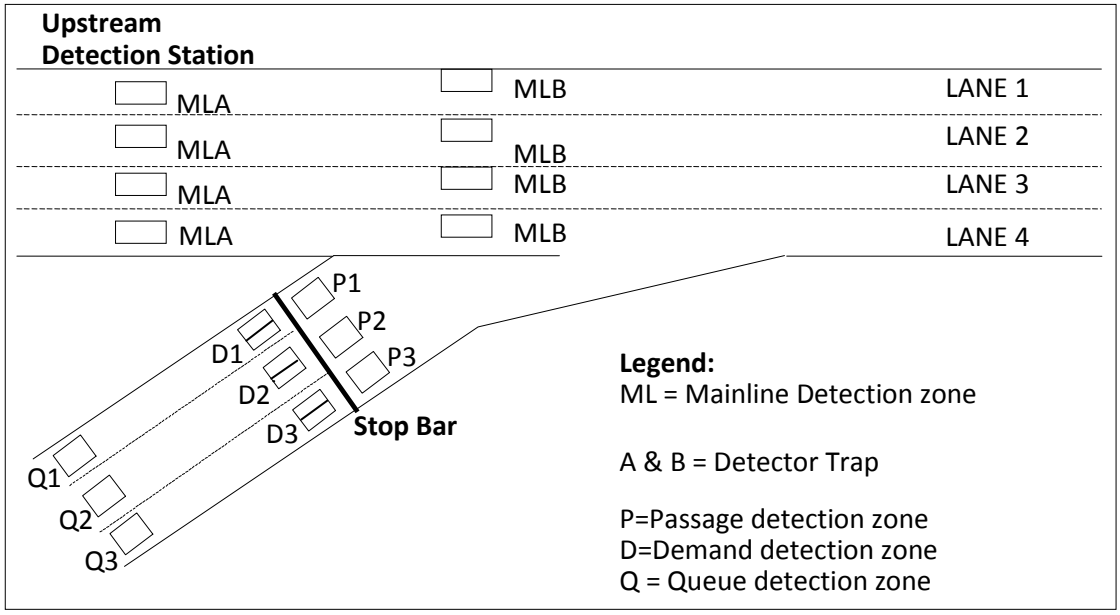


Figure 1: Typical Ramp Meter Layout

Lane numbering shall began at the median for mainline travel lanes. Lane numbering for ramp meter lanes shall began with the lane adjacent to the mainline travel lanes,

I-VDS is also used as a prefix to identify the individual I-VDS components as follows:

- I-VDSnnnVCS: the video camera sensor for "nnn" direction, type of detection and lane assignment
- I-VDSnnnCC: the coaxial cable from the video camera to the controller cabinet for approach "nnn" direction, type of detection and lane assignment
- I-VDSnnnPC: the video camera sensor power cable from the video camera to the controller cabinet for approach "nnn" direction, type of detection and lane assignment
- I-VDSnnnCSS: the coaxial cable surge suppressor in the controller cabinet for approach "nnn" direction, type of detection and lane assignment
- I-VDSnnnCJ: the coaxial jumper cable from the coaxial surge suppressor in the controller cabinet to the processor module or detector panel for approach "nnn" direction, type of detection and lane assignment
- I-VDSnnnPM: the processor module for approach "nnn" direction , type of detection and lane assignment

C. **Accuracy Requirements for I-VDS**

Provide I-VDS that meet the minimum accuracy requirements for both daytime and night time conditions:

1. For volume (vehicle counts): 95% (no more than 5% missed actuations).
2. For speed measurement: 95% (no more than +/- 5% error in speed calculation)
3. For occupancy measurement: 95% (no more than +/- 5% error in occupancy calculation)
4. For presence detection: 96% (no more than +/- 4% missed actuations)
5. For passage detection: 95% (no more than +/- 5% missed actuations)

D. **Testing**

Vendors are required to submit an independent test evaluation report from a third party which verifies the accuracies stated within their specifications.

Independent third-party verification (ITPV) is defined as the evaluation of the conceptual, functional, and technical requirements of a product being reviewed by one or more independent third parties qualified by their education, training, and experience in the same discipline, to judge the worthiness of the products' likelihood of achieving the intended objectives and anticipated outcomes.

Develop and submit plans for pre-installation and post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.03B and the accuracy requirements stipulated in Section 937.2.03C. Provide the Engineer with Application Protocol Interface (API) documentation and Software Development Kit (SDK) for the video detection system.

1. Pre-installation test requirements: Include at a minimum the following procedures in the test plan to demonstrate the I-VDS provides all the functional requirements in Section 937.2.03B and meets the accuracy requirement stipulated in Section 937.2.03C. Install no detection systems specified in the Plans until the pre-installation testing has been successfully completed.
    a. Install a test video detection system at a location determined by GDOT. Install a new video sensor for the test. Install a test detection system that includes all components of the system including a video sensor, a video detection processor and software.
    b. Configure the test system with at least 24 detection zones, including presence, passage, volume, speed, and occupancy.
    c. Demonstrate that each required data element is gathered by the system at the user-specified interval. Prove the accuracy of the detection system meets requirements in Section 937.2.03C by:
        1) Driving a vehicle of known speed and length through the detection zone and observing and recording the speed and length calculated by the system. Repeat this measurement at least ten times.
        2) Drive a vehicle into a presence detection zone and ensure the system recognizes the presence of the vehicle.
        3) Drive a vehicle into a passage detection zone and ensure the system recognizes the passage of the vehicle.
        4) Perform the above accuracy tests in both night and day conditions.
        5) Upon GDOT acceptance of pre installation test results, begin the installation of I-VDS as specified in the plans
        6) If any part of the pre installation test fails, the contractor has up to two subsequent attempts to correct the problem to the satisfaction of the Engineer. All subsequent attempts must be completed within two weeks of the initial failure.

2. Post-installation test procedures: Utilize the following test procedures after the detection system has been installed in its entirety as shown on the Plans and as required by manufacturers' recommendations. Commence no post-installation testing until all video detection systems in the project have been configured/calibrated with the detection zones as shown in the plans.

    a. Inspect all I-VDS field components to ensure proper installation and cable termination.

    b. Verify that field construction has been completed as specified in the plans.

    c. Inspect the installation of grounding and the surge protection systems.

    d. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.

    e. Verify that the installation of cables and connections between all detectors and field cabinets are as specified in the Plans

    f. Demonstrate each I-VDS is fully operational and gathering the required data types for each detection zone.

    g. Begin a 30-day burn test and ensure the system remains fully operational during the 30 day period as stipulated in Section 647.3.06.C.

937.3 Construction/Installation Requirements

937.3.01 Quality Control

A. **Training**

Provide a minimum of at least eight (8) hours of configuration and maintenance training. The persons to be trained will be determined by the Engineer. Configuration training should last a minimum of three (3) hours and must include instructions for programming, hands on training in programming detection zones, adjusting, and calibrating the detection system. One hands on unit shall be provided per attendee during training. Maintenance training should last a minimum of five (5) hours and must include instructions on troubleshooting, maintenance, and operation for all detection system components. Each class will have a maximum of eight (8) people. The contractor must provide a training notebook to each trainee and an electronic copy of the training notebook to the Engineer.

The contractor must provide a location for holding the courses and pay all costs associated with travel and accommodation of the trainees if training is conducted away from the project area.

Notify the Engineer 20 days before training and agree on a time and place to conduct the training. If agreement cannot be reached, the Engineer will determine the time

B. **Warranty**

Provide complete detection system equipment and software with a minimum (2) year warranty which begins once GDOT has provided notification that all devices have successfully passed the 30-day burn.

When the Department detects a failure of any component of the system during the warranty period, the Department will notify the Contractor, Distributor, and/or Manufacturer in writing of the problem.

Correct the problem within seven calendar days after receiving the notification or else pay liquidated damages in the amount of $600 per calendar day until the problem is corrected. Repair or replace the defective device(s) and ensure that all vehicle detection affected by the problem is brought within original accuracy parameters. The problem will be considered resolved when the Department has verified accuracy.

Ensure the Manufacturer/Contractor/Distributor will repair any faulty equipment during this period at no cost to the Department for parts, labor, or shipping to and from the factory.

Both a hardcopy and electronic copy of the warranty, including its date of inception and contact information for a manufacturer representative must be provided to the Engineer.

C. **Support**

During the warranty period, supply any firmware or software upgrades associated with the detection system to the Department at no charge. In addition, provide phone consultation as needed at no cost during the warranty period for operating questions or problems that arise.

If the Department desires, it may enter into a separate agreement with the suppliers for technical support and software upgrades. Make available such a program to the Department after the original warranty period.

937.3.02 Video Detection System Installation Requirements

A. **General Installation Requirements:**

Install all video camera sensors, video detection system processors, and associated enclosures and equipment at the locations specified in the Plans. Install all rack-mounted equipment with one rack unit space between adjacent equipment.

Installation must comply with manufacturer's recommendation. All equipment, cables, and hardware must be part of an engineered system that is designed by the manufacturer to fully interoperate with all other system components. Connectors installed outside the cabinets and enclosures must be corrosion resistant, weather proof, and watertight. Exposed cables must be UV and weather resistant. Label cables with permanent cable labels at each end.

Install VPU with a Model 2070 controller assembly. Install VDS power supply or transformer on a standard DIN rail using standard mounting hardware and power conductors wired to terminal blocks in the controller cabinet.

Wire each VDS sensor assembly to the controller cabinet with a wiring harness that includes all power, control wiring, and coaxial video cable. Attach harness with standard Mil spec type and rated plugs. Cable type and wire characteristics must comply with manufacturer's recommendations for the VDS to cabinet distance for the project.

Wiring and cables must be continuous (without splices) between the VDS sensor and controller cabinet. Coil a minimum of 2 (.61m) feet of slack in the bottom of the controller cabinet. For setup and diagnostic access, terminate serial data communication output conductors at TB-0. Tape ends of unused and spare conductors to prevent accidental contact to other circuits. Label conductors inside the cabinet for the functions depicted in the approved detailed diagrams.

Furnish an as-built cabinet wiring diagram, identified by location, for each VDS cabinet. Include all wiring, cabling, connections, and camera mounting height. Place all documentation in a weatherproof holder in the cabinet.

1. Camera Sensor Operating Locations

Adjust the video camera sensor lens to match the width of the road and minimize vehicle occlusion. Mount the camera on the specified pole or structure for that location as shown on the plans.

2. Cabinet Types

- Type A Cabinet – The Type A cabinet housing is a standard Model 336 stretch (336S) housing with approximate exterior dimensions of 46 in. (1.2 m) (H) x 24 in. (0.61 m) (W) x 23 in. (0.58 m) (D).
- Type B Cabinet - The Type B cabinet housing is a standard Model 337 housing with approximate exterior dimensions of 35 in. (0.89 m) (H) x 20 in. (0.5 m) (W) x 17 in. (0.43 m) (D).
- Type C Cabinet - The Type C cabinet housing is a standard Model 332 housing with approximate exterior dimensions of 64 in. (1.6 m) (H) x 24 in. (0.61 m) (W) x 30 in. (0.76 m) (D).
- Type D Cabinet – The Type D cabinet housing is a standard Model 336 stretch (336S) housing with approximate exterior dimensions of 46 in. (1.2 m) (H) x 24 in. (0.61 m) (W) x 23 in. (0.58 m) (D). The difference between a Type D and Type A cabinet is the difference in interior cabinet configuration as shown in the Detail Drawings in this section.

- Type F Cabinet - The Type F cabinet housing shall be a standard ITS Cabinet Housing #3 with approximate exterior dimensions of 67 in. (1.7 m) (H) x 44 in. (1.2 m) (W) x 26 in. (0.66 m) (D).

The cabinet type to be used will be shown in the plans.

3. Cabinet Equipment

a. Wiring, Conductors and Terminal Blocks: Use stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which may be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Route camera control wiring, and 120 VAC power wiring separately. Terminate all wiring on a terminal block, strip, bussbar, or device clamp or lug; do not splice any wiring. Use a minimum #12 AWG for all conductors of 120 VAC circuits.

Label coaxial cables for VDS cameras between SS1 -SS22 and the VDS video input "CX" where the "X" indicates the surge suppressor identifier (e.g., cable C9 connected to SS17, cable C10 connected to SS18.)

Number all terminal blocks, terminal strips, circuit breakers and bussbar breakers and have each item and each terminal position numbered and named according to function as shown in the "quoted labels" in the Detail Drawings. Label terminal blocks, terminal strips, circuit breakers and bussbars with silk screened lettering on the mounting panel.

b. Surge Suppression: Protect all copper wiring and cabling entering the cabinet housing, except for the earth ground conductor, by surge suppression devices as specified. Terminate all wiring between cabinet devices and the transient surge suppressors, except for the video signal coaxial feed, on terminal strips. Use a minimum #16 AWG grounding of each surge suppression device, or larger if recommended by the surge suppression device manufacturer. Use insulated green wire and connect the ground wire directly to the ground bussbar. Do not "daisy chain" with the grounding wires of other devices including other surge suppressors. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute minimum length possible between the suppressor and the ground bussbar. Label all surge suppressors with silk-screened lettering on the mounting panel.

Use minimum #18 AWG insulated black wiring between the surge suppression device sockets and the terminal blocks for the protected circuits.

Furnish and install a surge suppressor (SS17 through SS22 as required) for each video signal coaxial line. For each cabinet housing, include surge suppressor SS16 for the VDS camera power lines installed on TB2.

c. Component Installation: Fasten all components of the cabinet assembly to be mounted on cabinet side panels with hex-head or phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. These components include but are not limited to terminal blocks, bussbars, panel and socket mounted surge suppressors, accessory and equipment outlets, and DC power supply chassis. Fasten all other cabinet components with hex-head or phillips-head machine screws insulated with nuts (with locking washer or insert) or into tapped and threaded holes. All fastener heads and nuts (when used) shall be fully accessible within a complete cabinet assembly, and any component shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping or self-threading fasteners.

d. Mounting Bracket Assembly**:** Mount the video camera sensor on a mounting bracket assembly as shown in the details such that its height and position provide a clear view of the approach or lanes in ramp metering operations. Mount the video camera sensor securely such that it is stable and steady. The mounting bracket assembly includes a video camera sensor mounting bracket, nipple pipe, cable-mount nipple clamp, and all associated hardware and materials. Mount the video camera sensor on a mounting bracket assembly which meets the following requirements unless otherwise specified in the plans:

1) Use stainless steel fastening hardware with lock washers on threaded fasteners

2) Use a video camera sensor enclosure mounting bracket that is non-rusting and is made from die cast aluminum, extruded aluminum, powder-coated galvanized steel or hot dipped galvanized steel. Provide a mounting bracket that permits vertical and horizontal adjustment of the video camera sensor. Provide a mounting bracket that securely fastens to the video camera sensor enclosure and mounts to the nipple pipe by threading onto the pipe or as a slip-fit, using a set-screw fastener in either above method.

3) Use a 1 ½" (38 mm) aluminum nipple pipe that is threaded on both ends.

4) Fasten the nipple pipe to the mast arm using a cable mount nipple clamp with minimum 2 5/16" (58 mm) U bolts. Use aircraft grade galvanized steel cables with stainless steel fastening hardware and that make at least two wraps around the mast arm. Do not use banding straps.

e. Video camera sensor junction box: If approved for use, provide a wiring junction box with mounting hardware for termination/connection of the sensor housing wiring with the field cabling from the traffic signal/ramp meter controller cabinet as shown in the details. Provide a cast aluminum or 0.125" (3.175 mm) sheet aluminum box with maximum inside dimensions of 8" H x 8" W x 4" D (200 mm H x 200 mm W x 100 mm D). Do not use steel- or plastic-bodied junction boxes. Provide a box that is NEMA 4 rated dust-tight, rain tight, and watertight and has a hinged and neoprene-gasketed door with stainless steel hinge pins and threaded fasteners for closing. Provide a 1 ½" (38 mm) slip hole with rubber grommet with poke-through diaphragm for cable entry in the bottom of the box; no other holes in the box body shall be permitted except as required for the mounting U-bolts as shown in the details. Provide a 3-position fully-enclosed compact terminal strip rated for minimum 15 A current and #14 AWG conductors. Internal connectors shall be nickel-plated threaded fasteners for securing the conductors. The terminal strip shall be fully enclosed and covered with no exposed current-carrying metal surfaces. Label the three positions on the terminal strip as "AC+", "AC-", and "GR" with fastener secured or epoxy-cement permanent labels; do not use adhesive or self-stick labels. Provide a female-female BNC coupler with gold-plated body and center pin sockets, electrically isolated from the junction box by fastening to a non-conductive bracket mounted to the junction box side.

f. Documentation: Provide the following documentation in the documentation pouch of each traffic signal/ramp meter cabinet:

- One operation manual with programming instructions
- One maintenance manual with schematics
- Three legible wiring prints showing all I-VDS components and connections with the cabinet

g. Type D Cabinet Equipment

Install cabinet equipment as shown in Detail Drawing 937.1

h. Cables, Conduit, and Power Service

Furnish and install electrical cables used for video, control, communications signaling and power supply as shown in the Detail Drawings. Do not splice any cable, shield or conductor used for video, control, communications signaling, or power supply. Identify all conductors of all cables by color and number. Identify the conductor function in as-built documentation included in the cabinet documentation. Terminate cable used for video signaling in BNC connectors. After terminating and dressing the cables in the cabinet, neatly coil and store a minimum of 2 ft (.61 m) of cable slack in the bottom of the cabinet. Cut unused conductors to a length that can reach any appropriate terminal. Bend back unused conductors over their outer jackets and individually tape them.

Provide electrical cables for video, communications signaling and power supply between the cabinet and the device as required below and install them as shown in the Detail Drawings.

Beginning at individual video camera sensors, carry video signals from the camera to the pole-mounted junction/splice cabinet via coaxial cable to the video detection system processor located in the field cabinet. Transmit the vehicle traffic data from the video detection system processor to a traffic control center via the Ethernet network system.

Install cabling inside new hollow metal or concrete support poles unless otherwise specified. Use weather heads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and chafing against the pole, device or bracket. Form a drip loop at the weather head and route cabling to minimize water entry into the cable connector. Use a 24" diameter drip loop where cables enter a weatherhead.

i. As-Built Drawings

Furnish an as-built cabinet wiring diagram, identified by location, for each VDS cabinet. Include all wiring, cabling, connections, and camera mounting height. Place all documentation in a weatherproof holder in the cabinet.

937.3.03 Microwave Detection System Installation Requirements

A. **General Installation Requirements**

Install all detectors and associated equipment at the locations specified in the Plans. Installation must comply with manufacturer's recommendation. All equipment, cables, and hardware must be part of an engineered system that is designed by the manufacturer to fully interoperate with all other system components.

1. Detector

Install the microwave radar detector on poles as shown in the plans using supplied materials and brackets. Install the microwave radar detector to achieve the field of coverage shown in the Plans. Make field adjustments to the locations shown in the Plans only with the Engineer's approval. Set up the detection zones using a laptop computer and software provided by and the property of the Contractor.

2. Cabinet Equipment

a. Wiring, Conductors, and Terminal Blocks: Use stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which may be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Route microwave radar detector control wiring and 120VAC power wiring separately. Terminate all wiring on a terminal block, strip, bussbar, or device clamp or lug; do not splice any wiring. Use a minimum #12 AWG for all conductors of 120VAC circuits. Install all wiring as shown in the Detail Drawings.

Number all terminal blocks, terminal strips, circuit breakers and bussbar breakers and have each item and each terminal position numbered and named according to function as shown in the "quoted labels" in the Detail Drawings. Label terminal blocks, terminal strips, circuit breakers and bussbars with silk-screened lettering on the mounting panel.

b. Surge Suppression: Protect all copper wiring and cabling entering the cabinet housing, except for the earth ground conductor, by surge suppression devices as specified. Terminate all wiring between cabinet devices and the transient surge suppressors and between the microwave radar detection unit and the surge protectors on terminal strips. Use a minimum #16 AWG grounding for each surge suppression device, or larger if recommended by the surge suppression device manufacturer. Use insulated green wire and connect the ground wire directly to the ground bussbar. Do not "daisy chain" with the grounding wires of other devices including other surge suppressors. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute

minimum length possible between the suppressor and the ground bussbar. Label all surge suppressors with silk-screened lettering on the mounting panel.

Use minimum #18 AWG insulated black wiring between the surge suppression device sockets and the terminal blocks for the protected circuits.

Furnish two (2) transient surge suppressors for the microwave radar detection units (SS24 and SS25).

c. Component Installation: Fasten all components of the cabinet assembly to be mounted on cabinet side panels with hex-head or phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. The components include but are not limited to terminal blocks, bussbars, panel and socket mounted surge suppressors, Ethernet switches, circuit breakers, and accessory and equipment outlets. Fasten all other cabinet components with hex-head or phillips-head machine screws installed with nuts (with locking washer or insert) or into tapped and threaded holes. Fasten stud-mounted components to a mounting bracket providing complete access to the studs and mounting nuts. All fastener heads and nuts (when used) shall be fully accessible within a complete cabinet assembly, and any component shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping of or self-threading fasteners.

d. As-Built Drawings: Furnish an as-built cabinet wiring diagram, identified by location, for each cabinet. Include all wiring, cabling, and connections. Place all documentation in a weatherproof holder in the cabinet.

3. Cables, Conduit and Power Service

Furnish and install electrical cables used for control, communications signaling and power supply as required below and as shown in the Detail Drawings. Do not splice any cable, shield or conductor used for control, communications signaling, or power supply. Identify all conductors of all cables by color and number. Identify the conductor function in as-built documentation included in the cabinet documentation. After termination and dressing the cables in the cabinet, neatly coil and store a minimum of 2 ft (.61m) of cable slack in the bottom of the cabinet. Cut unused conductors to a length that can reach any appropriate terminal. Bend back unused conductors over their outer jackets and individually tape them.

Install cabling inside new hollow metal or concrete support poles unless otherwise specified. Where devices are installed on existing wood poles, install cabling on the wood poles in rigid metal conduit risers of minimum 2 in (5.08 cm) diameter. Use weather heads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and chafing against the pole, device or bracket. Form a drip loop at the weather head and route cabling to minimize water entry into the cable connector. Use a 24” diameter drip loop where cables enter a weatherhead.

4. As-Built Drawings

Furnish as-built drawings, including but not limited to microwave radar detection locations, microwave radar detection mounting heights, and component lists with brand, model and serial numbers. Place one copy of the as-built drawings in the cabinet documentation pouch and submit another copy to the Engineer.

937.3.04 Intersection Video Detection System Installation Requirements

A. **General Installation Requirements**

Install all video camera sensors, processor modules, output expansion modules, and associated equipment at the locations specified in the Plans. Mount the processor and output expansion modules within the traffic signal/ramp meter controller cabinet input files. No physical changes are permitted to the traffic signal/ramp meter controller cabinet input files. Make all necessary adjustments and modifications to the detection system prior to obtaining ~~r~~ecommendation for system acceptance from the TMC and/or District Engineer. Installation must comply with manufacturer’s recommendation.

Provide all programming equipment, documentation and incidentals needed for the installation, configuration and calibration of all detection system materials. This requirement includes but is not limited to equipment

documentation, programming monitors, programming devices, and lens adjustment devices. Provide programming equipment during all installation and testing work.

All programming equipment shall be returned to the Engineer as a property of the State.

Perform all programming and configuration to all I-VDS and traffic signal controller and cabinet equipment for the full and complete operation of the detection system.

1. Video Camera Sensor

Install a video camera sensor with mounting bracket assembly as shown in the Plans or in accordance with the manufacturer's recommendations. Install the video camera sensor in the vertical and horizontal positions as specified to provide the field of view and detection zones shown in the Plans. Make field adjustments to the positions specified in the Plans only with the Engineer's approval.

2. Programming Monitor

After all I-VDS programming is completed and accepted, deliver the programming monitor, associated materials such as the user manual and the packing container, and the video cables, to the Engineer at the project location or the Engineer's offices. Do not leave the monitor in the traffic signal/ramp meter cabinet.

3. Programming Device

After all I-VDS programming is completed and accepted, place the programming device with connector cord in a zipper- or snap-type re-sealable plastic bag in the cabinet documentation pouch.

4. Processor Module

Install the processor module in the cabinet input file and fully program and configure the module as shown in the Plans and in accordance with the manufacturer's recommendations. Ensure proper operation, including accurate detection, as programmed. Provide all equipment and materials necessary for programming and configuration, including a video display monitor.

5. Expansion Module

Install the expansion module in the cabinet input file and fully program and configure the module as shown in the Plans and in accordance with the manufacturer's recommendations. Ensure proper operation, including accurate detection, as programmed.

6. Field Cabling

Field cabling consists of separate video coaxial cable and the camera sensor power cable and/ or composite cable from the controller cabinet in accordance with manufacturer's recommendation. Field cable installation shall be continuous from the camera to the control cabinet. Do not splice any field cabling. Other methods may be approved by the Engineer.

Install the field cabling for each video camera sensor as shown in the Plans, or junction box if used, in accordance with the manufacturer's recommendations, and in accordance with the requirements for signal cable in Section 647 Traffic Signal Installation. Ensure that cable installation is complete from the video camera sensor junction box to the coax and power termination panels in the controller cabinet.

Label all field cabling within three inches of termination using clear overwrapping self-laminating cable labels and the appropriate cable label identification as defined in Section 937.3.03.A.7a-c and shown in the details. Label field cabling in the camera sensor, in the controller cabinet, and in all pull boxes and pole bases. After terminating and dressing the video camera sensor coaxial and power cables in the controller cabinet, neatly coil and store a minimum of 2ft (.61 m) of cable slack in the bottom of the cabinet. Provide a label for each cable for 2ft (.61 m) of cable slack.

Use a video coaxial field cable (labeled as "I-VDSnCC") that is double-shielded with tinned copper braid, #20 AWG solid copper center conductor, and polyethylene outer jacket approved for outdoor use. Terminate both ends of the coaxial cable per manufacturers requirements, if BNC connectors are used terminate with gold-plated body and center pin and as recommended by the cable manufacturer

Use a camera sensor power field cable (labeled as "I-VDSnPC") that is a 6-conductor cable with #16 AWG stranded copper conductors. Use a cable that is ozone and UV resistant, suitable for wet use, with a 600 V and 105 degree rating, is UL listed for indoor and outdoor use, and with 120 VAC standard black/white/green solid colored conductor insulation.

7. Cabinet Equipment

Install cabinet equipment as shown in the details and as required to provide the controller operation as shown on the Plans. Cabinet equipment shall include as a minimum an I-VDS power termination panel, an I-VDS coax termination panel, one or more coaxial cable surge suppressors, one or more coaxial jumper cables, power surge suppressor and all associated wiring and incidental materials.

General: Provide an I-VDS power and coax termination panel assembly and all associated materials in the controller cabinet for installation, including power distribution termination, power surge suppressor, video camera field cabling termination, video jumper cables, and surge protection in accordance with the manufacturer's recommendation.

Coaxial cable surge suppressors: Use either common-ground or balanced-differential video signal surge suppressors in accordance with the I-VDS manufacturer's recommendations. Use surge suppressors that have solid-state, hybrid clamping technology, and have equipment-side and field-side BNC connectors on the top of the suppressor enclosure as shown in the details.

Coaxial Jumper Cable: Use a video coaxial jumper cable (labeled as "I-VDSnJC") to connect the equipment (protected) terminal of the video signal surge suppressor directly to the processor module as applicable. Use a video coaxial jumper cable that is a high-flex cable or as recommended by the cable manufacturer, with double-shield tinned copper braid, #20-22 AWG stranded copper center conductor and polyethylene outer jacket. As applicable, terminate both ends or one end of the coaxial cable with BNC connectors with gold-plated body and center pin and as recommended by the cable manufacturer. Use coaxial jumper cables of the length necessary to route as shown in the details with no mechanical strain on the end connectors and no excess cable loops to be stored. Label coaxial jumper cables within three inches of end connectors using clear overwrapping self-laminating cable labels and the appropriate cable label identification ("I-VDSnJC") for the video camera sensor and processor module as shown in the Plans.

Exercise extreme caution when installing I-VDS equipment and materials at traffic signal/ramp meter installations. Repair any damage to existing traffic/ramp meter control equipment and materials which occurred during I-VDS installation to the Engineer's satisfaction at the Contractor's sole expense.

In 336S cabinets, locate the I-VDS power termination panel on the equipment rail in the lower left portion of the rear of the cabinet as shown in the details. Adjust the panel as far toward the cabinet sidewall as possible while still providing access to the circuit breaker. Notify the Engineer immediately if there is any conflict with existing cabinet equipment in this position. Ensure that there is no conflict with door-mounted components when the door is closed.

In 332 and 334 cabinets, locate the I-VDS coax termination panel in the lower open section of the front of the cabinet equipment rack as shown in the details. Notify the Engineer immediately if there is any conflict with existing cabinet equipment in this position. Ensure that there is no conflict with door-mounted components when the door is closed. Dress, label, and secure all coaxial cabling to and from the coax termination panel such that the panel can be hinged open a minimum of 90 degrees without binding or stressing any coaxial cable.

8. As-Built Drawings

Furnish as-built drawings, including but not limited to video camera sensor locations, video camera sensor mounting heights, details on the field cabling route through the intersection, and component lists with brand, model and serial numbers. Place one copy of the as-built drawings in the cabinet documentation pouch and submit another copy to the Engineer.

937.4 Measurement

937.4.01 Video Detection System

A. **Video Camera Sensor Assembly**

Video camera sensor assemblies paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a video camera sensor assembly.

1. Camera, environmental enclosure, and mounting assembly with all associated hardware.
2. Cabinet equipment, including but not limited to wiring, conductors, terminal blocks, surge suppression, field switch and the sliding drawer.
3. All weather heads, vertical conduit risers, and conduit hardware on the VDS support pole for power service, grounding, communications, and control. If VDS and CCTV are mounted on the same pole, install common weather heads, conduit risers, and conduit hardware under Section 936 of the Specifications.
4. All hardware and materials necessary to provide electrical power service to the VDS field location as shown in the Plans, including but not limited to vertical sections of conduit, conduit hardware, wire, circuit breakers, disconnect closures, and grounding. The Department will pay for horizontal sections of conduit separately.
5. All cables, connectors, hardware, interfaces, supplies, and any other items necessary for the proper operation and function of any VDS system component to carry video signals to the video detection system processor.

B. **Video Detection System Processor, Type A**

Video detection system processors paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install a video detection system processor to include, at a minimum, the following:

Video detection system processor equipment with two video inputs.

System software provided within the video detection system processor

C. **Video Detection System Processor, Type B**

Video detection system processors paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install a video detection system processor to include, at a minimum, the following:

Video detection system processor equipment with four video inputs.

System software provided within the video detection system processor

D. **Testing**

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

E. **Training**

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

937.4.02 Microwave Radar Detection

A. **Microwave Radar Detector Assembly**

Microwave radar detection assemblies paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a microwave video detection assembly:

- Microwave radar detector
- Housing
- Field cabling and cabinet equipment
- Power supply
- Mounting bracket(s)
- All weatherheads, vertical conduit risers, and conduit hardware on the support pole for power and detector signal as shown in the plans
- Configuration

B. **Testing**

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

C. **Training**

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

937.4.03 Intersection Video Detection System

A. **Intersection Video Detection System Assembly**

Intersection Video Detection System Assemblies paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for an Intersection Video Detection System Assembly:

1. Intersection Video Detection Assembly, Type A
    a. Video Camera Sensor:
        1) Camera, environmental enclosure, variable focal length lens, mounting bracket assembly, with all associated hardware and incidental materials
        2) Electric Lens Adjustment Device; if more than one video camera sensor is installed at an intersection, provide one Electric Lens Adjustment Device for that intersection
        3) Field cabling and cabinet equipment, including but not limited to power and video cabling from the video camera sensor to the controller cabinet, processor module, power and coax termination panels, surge suppressor, cabinet wiring, and all associated hardware and incidental materials. If more than one Intersection Video Detection Assembly and/or video camera sensor is installed at an intersection or ramp meter installation, provide one power termination panel and one coax termination panel for that intersection or ramp meter installation.
        4) All weather heads, vertical conduit risers, and conduit hardware on the I-VDS support pole for power and video signal as shown in the Plans
    b. Processor Module:
        1) Provide one Processor Module, Type A
        2) Configuration and processor software on the processor module
        3) Programming Device; if more than one Processor Module is installed in a cabinet at an intersection, provide one Programming Device for that cabinet
2. Intersection Video Detection Assembly, Type B
    a. Video Camera Sensor:

1) Provide two (2) cameras, environmental enclosures, variable focal length lenses, mounting bracket assemblies, and junction boxes with all associated hardware and incidental materials

2) Electric Lens Adjustment Device; if more than one video camera sensor is installed at an intersection, provide one Electric Lens Adjustment Device for that intersection

3) Field cabling and cabinet equipment, including but not limited to power and video cabling from the video camera sensors to the controller cabinet, processor modules, power and coax termination panels, surge suppressors, cabinet wiring, and all associated hardware and incidental materials. If more than one Intersection Video Detection Assembly and/or video camera sensor is installed at an intersection or ramp meter installation, provide one power termination panel and one coax termination panel for that intersection or ramp meter installation.

4) All weather heads, vertical conduit risers, and conduit hardware on the I-VDS support pole for power and video signal as shown in the Plans

b. Processor Module:

1) Provide one Processor Module, Type B or C

2) Configuration and processor software on the processor module

3) Programming Device; if more than one Processor Module is installed in a cabinet at an intersection, provide one Programming Device for that cabinet

B. **Output Expansion Module**

Output expansion modules paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install an Output Expansion Module to include, at a minimum, the following:

Output expansion module

Any cabling required to connect to the processor module or additional expansion modules

C. **Programming Monitor**

A Programming Monitor is measured for payment by the number actually furnished and accepted. Unless otherwise specified in the Plans, furnish a Programming Monitor to include, at a minimum, the following:

Programming Monitor

Any cabling required to connect the processing modules to the programming monitor

D. **Testing**

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

E. **Training**

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

937.5 Payment

937.5.01 Video Detection System

A. **Video Camera Sensor Assembly**

Video camera sensor assemblies, complete in place and accepted by the Department, are paid for at the Contract Unit Price. Payment is full compensation for furnishing and installing the video camera sensor assembly.

B. **Video Detection System Processor, Type A**

Video detection system processors, complete in place and accepted by the Department, are paid for at the Contract Unit Price. Payment is full compensation for furnishing and installing the video detection system processor.

C. **Video Detection System Processor, Type B**

Video detection system processors complete in place and accepted by the Department, are paid for at the Contract Unit Price. Payment is full compensation for furnishing and installing the video detection system processor.

D. **Testing**

The Department will pay for testing performed as prescribed by this Item, measured as provided under Measurement at the Lump Sum Contract bid price.

E. **Training**

The Department will pay twenty-five (25%) of the total Lump Sum Contract bid amount for training upon approval of the Training Plan. The Department will pay the remaining seventy-five (75%) after completion of all training as described in Subsections 937.2.01. The total sum of all payments cannot exceed the original contract amount for this item.

Payment is full compensation for furnishing and installing the items complete in plans according to this Specification.

937.5.02 Microwave Detection System

A. **Microwave Radar Detector Assembly**

Microwave radar detection assemblies paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a microwave video detection assembly:

- Microwave radar detector
- Housing
- Field cabling and cabinet equipment
- Power supply
- Mounting bracket(s)
- All weatherheads, vertical conduit risers, and conduit hardware on the support pole for power and detector signal as shown in the plans
- Configuration

B. **Testing**

Testing is paid for as a lump sum for full delivery of testing and acceptance requirements, measured as provided under Measurement at the Lump Sum Contract bid price

C. **Training**

Training is paid for as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training, measured as provided under Measurement at the Lump Sum Contract bid price

Payment is full compensation for furnishing and installing the items complete in plans according to this Specification.

937.5.03 Intersection Video Detection

A. **Intersection Video Detection Assembly**

Intersection Video Detection System Assemblies paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for an Intersection Video Detection System Assembly:

1. Type A
    a. Video Camera Sensor:
        1) Camera, environmental enclosure, variable focal length lens, mounting bracket assembly, with all associated hardware and incidental materials
        2) Electric Lens Adjustment Device; if more than one video camera sensor is installed at an intersection, provide one Electric Lens Adjustment Device for that intersection
        3) Field cabling and cabinet equipment, including but not limited to power and video cabling from the video camera sensor to the controller cabinet, processor module, power and coax termination panels, surge suppressor, cabinet wiring, and all associated hardware and incidental materials. If more than one Intersection Video Detection Assembly and/or video camera sensor is installed at an intersection or ramp meter installation, provide one power termination panel and one coax termination panel for that intersection or ramp meter installation.
        4) All weather heads, vertical conduit risers, and conduit hardware on the I-VDS support pole for power and video signal as shown in the Plans
    b. Processor Module:
        1) Provide one Processor Module, Type A
        2) Configuration and processor software on the processor module
        3) Programming Device; if more than one Processor Module is installed in a cabinet at an intersection, provide one Programming Device for that cabinet
2. Type B
    a. Video Camera Sensor:
        1) Provide two (2) cameras, environmental enclosures, variable focal length lenses, mounting bracket assemblies, and junction boxes with all associated hardware and incidental materials
        2) Electric Lens Adjustment Device; if more than one video camera sensor is installed at an intersection, provide one Electric Lens Adjustment Device for that intersection
        3) Field cabling and cabinet equipment, including but not limited to power and video cabling from the video camera sensors to the controller cabinet, processor modules, power and coax termination panels, surge suppressors, cabinet wiring, and all associated hardware and incidental materials. If more than one Intersection Video Detection Assembly and/or video camera sensor is installed at an intersection or ramp meter installation, provide one power termination panel and one coax termination panel for that intersection or ramp meter installation.
        4) All weather heads, vertical conduit risers, and conduit hardware on the I-VDS support pole for power and video signal as shown in the Plans
    b. Processor Module:
        1) Provide one Processor Module, Type B or C
        2) Configuration and processor software on the processor module
        3) Programming Device; if more than one Processor Module is installed in a cabinet at an intersection, provide one Programming Device for that cabinet

3. Output Expansion Module

Output expansion modules paid for are the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install an Output Expansion Module to include, at a minimum, the following:

- Output expansion module
- Any cabling required to connect to the processor module or additional expansion modules

4. Programming Monitor

A Programming Monitor is measured for payment by the number actually furnished and accepted. Unless otherwise specified in the Plans, furnish a Programming Monitor to include, at a minimum, the following:

- Programming Monitor
- Video input Switching Device
- Any cabling required to connect the processing modules to the programming monitor

5. Testing

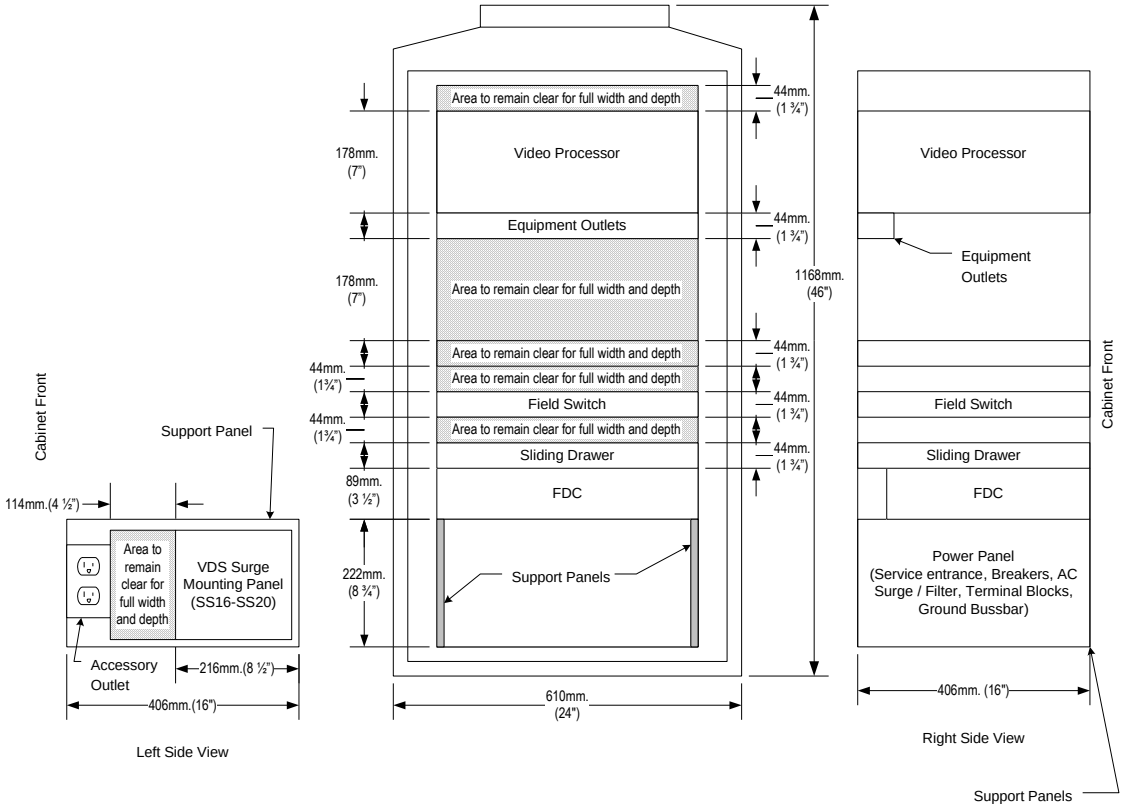
Testing is paid for as a lump sum for full delivery of testing and acceptance requirements, measured as provided under Measurement at the Lump Sum Contract bid price

6. Training

Training is paid for as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training, measured as provided under Measurement at the Lump Sum Contract bid price

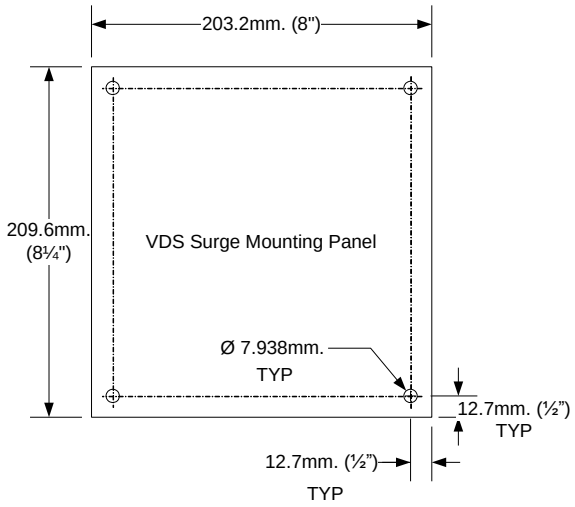
Payment will be made under:

Item No. 937	Video Camera Sensor Assembly	Per Each
Item No. 937	VDS System Processor, Type _	Per Each
Item No. 937	Testing - Video Detection System	Lump Sum
Item No. 937	Training - Video Detection System	Lump Sum
Item No. 937	Microwave Radar Detection Assembly	Per Each
Item No. 937	Testing - Microwave Detection System	Lump Sum
Item No. 937	Training - Microwave Detection System	Lump Sum
Item No. 937	Intersection Video Detection System Assembly, Type _	Per Each
Item No. 937	Output Expansion Module, Type _	Per Each
Item No. 937	Programming Monitor, Type _	Per Each
Item No. 937	Testing – Intersection Video Detection	Lump Sum
Item No. 937	Training – Intersection Video Detection	Lump Sum



Notes:
1. All dimension and scale are approximate.
2. FDC (Fiber Distribution Center) required and paid for in Section 935
3. Support Panels shall be mounted inside the cabinet rack cage.
4. Removal of a Support Panel or Mounting Panel shall not require the removal of any other cabinet component
5. Field Switch required and paid for in Section 939

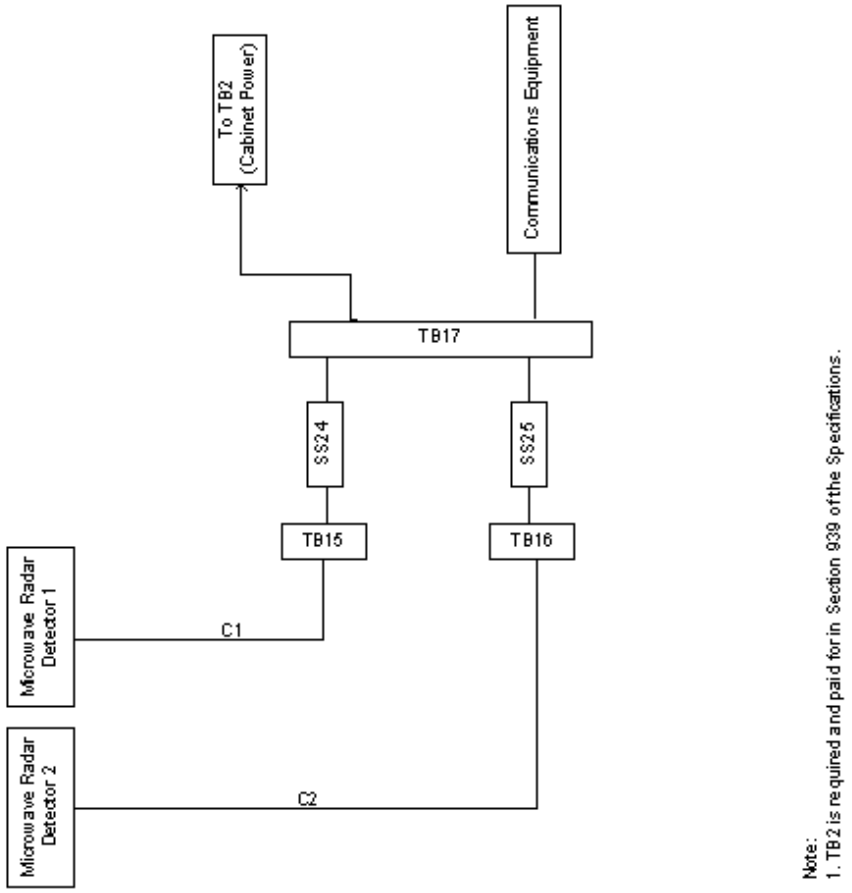
Detail Drawing 937.1
Type D Equipment Cabinet Assembly With VDS Equipment



Note:

1. All linear dimensions +\- 0.005" tolerance.
2. Drawing not to scale
3. Mounting Panel shall be 0.125" 5052 Aluminum

Detail Drawing 937.2
VDS Surge Mounting Panel, Type D Cabinet



Detail Drawing 937.3

Microwave Radar Detection Assembly Block Diagram